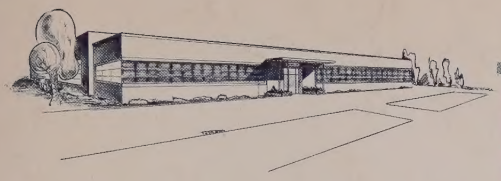

ITTF FIELD ENGINEERING
REFERENCE INFORMATION
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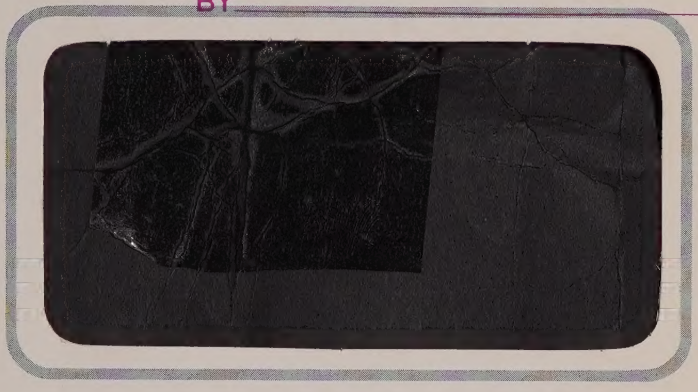


INDUSTRIAL AND NUCLEAR INSTRUMENTS

ANALOG COMPUTERS

Berkeley *division*

BECKMAN INSTRUMENTS, INC.
2200 WRIGHT AVE., RICHMOND, CALIF.
TELEPHONE: LANDSCAPE 6-7730

PRELIMINARY
INSTRUCTION MANUAL

MODEL 7580
TRANSFER OSCILLATOR

BECKMAN Instruments
Berkeley Division

15 August 1957
Richmond 4, Calif.

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect.

(b) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(c) The Company shall be released from all obligations under its warranty in the event repairs or modifications are made by persons other than its own service personnel or authorized representatives' personnel unless such repairs by others are made with the written consent of the Company.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

FOREWORD

The following manual contains instructions for operating the Model 7580 Transfer Oscillator when used in conjunction with the Model 7360J counter. The transfer oscillator may also be operated with other electronic counters, notably Model 7370, which has a maximum counting rate of 10Mcs. The method of operation is the same except that the counter function used is E/B instead of A/B. The frequency measuring capabilities are also the same except that frequencies as high as 10Mcs may be measured using the counter alone.

With the following changes the instruction manual will be appropriate for use with a Model 7370 counter:

Page 1, paragraph 1.11, line 3
Change "7360J" to read "7370"

Page 1, par. 1.2
Change first heading to read "ENTIRE SYSTEM (TRANSFER OSCILLATOR PLUS MODEL 7370 COUNTER.)"

Page 2, par. 2.1, line 2
Change "Model 7360J" to read "Model 7370"

Page 2, par. 2.1, step 1, line 2
Change " A INPUT jack" to read "E input jack."

Page 2, par. 2.1, step 5, line 2
Delete " The counter draws 325 watts"

Page 1, Figure 1
Change label in block representing the frequency counter to read "Model 7370" instead of "Model 7360J".

Page 6, Figure 3
Change label on FREQUENCY OUT jack to read "Couple to E input jack on counter".

Page 7, line 6
Change "75Mcs to 2.1Mcs" to read "75Mcs to 10Mcs."

Page 7, line 12
Change "2.1Mcs to d-c" to read "10Mcs to d-c".

Page 7, par. 2.3 step 2
Change to read "Adjust counter for E/B operation as described in the instruction manual on Model 7370".

Page 8, par. 2.3 step 8, line 6
Change "A/B" to read "E/B"

Page 8, Table 1
Change "A/B" to read "E/B". Change "A/B X 10" to read "E/B X 10".

Page 10, par. 2.6 line 26
Change "Model 7360J" to read "Model 7370"

Page 15, Figure 8
Within the block representing the counter change "7360J" to read "7370", change "A INPUT CHANNEL" to read "E INPUT CHANNEL", change "A INPUT" to read "E INPUT".

1. INTRODUCTION

1.1 GENERAL DESCRIPTION

1.11 Purpose. The Model 7580 transfer oscillator is designed to be used in conjunction with the Model 7360J counter to measure r-f frequencies ranging from 75 to 10,000Mcs. Frequencies below 75Mcs may be measured using special techniques. The instrument will accommodate several types of signals including continuous stable-frequency signals with or without amplitude modulation, frequency-modulated signals and pulsed r-f signals. All signals may contain considerable noise without affecting the ease or accuracy of measurement.

1.12 Principle of Operation. The transfer oscillator generates a fundamental frequency which may be varied from 75 to 150Mcs. It also generates all harmonics of this fundamental up to and beyond the 70th. To measure the frequency of an input signal, the fundamental is adjusted to the point where one of its harmonics has the same frequency as the input signal. This is done by beating the harmonic against the input signal and varying its frequency until the difference frequency, as observed on a built-in oscilloscope, is zero. Then, a frequency equal to precisely .01 of the fundamental is fed to the counter. Now, if the counter counted each cycle of this signal for .01, 0.1 or 1 second, the fundamental frequency would be displayed. To find the input frequency, then, we would have to multiply this indication by the harmonic number, n. To avoid this calculation, the counting period is expanded to n times the usual decimal period, with the result that the input frequency appears directly in decimal digits on the face of the counter.

Determining the harmonic number is likewise accomplished without calculation, in most cases. The operator simply locates two adjacent fundamentals, each of which produces a harmonic equal to the input frequency, then reads the harmonic number of the higher fundamental on a scale. The scale is a simple mechanical analog computer like a slide rule. It solves the equation:

$$n = \frac{f_L}{f_H - f_L}$$

where f_L = lower fundamental frequency

f_H = higher fundamental frequency

n = number of harmonic of f_H

Figure 1 shows the essential parts of the system.

1.2 SPECIFICATIONS

ENTIRE SYSTEM (TRANSFER OSCILLATOR PLUS MODEL 7360J COUNTER)

Frequency Measuring Range

75 to 10,000Mcs. Frequencies below 75Mcs may be measured using special techniques.

Type of Input Signal which can be Measured

Continuous stable-frequency signals with or without AM.
F-M signals
Pulsed r-f signals

Required Input Amplitude

Never more than 100mv rms, usually much less. See typical sensitivity curve, figure 2. Source impedance should be about 50 ohms.

Accuracy of Measurement

Depends upon input signal. See "ACCURACY".

TRANSFER OSCILLATOR

Fundamental Signal

Frequency: Continuously variable from 75 to 150 Mcs.
Frequency Stability: .0001 per cent per minute

Tuning Mechanism for Fundamental

Dial Calibration: 50kcs increments
Accuracy of dial setting: ±50kcs
Repeatability of dial setting: ±15Kcs

Tuning Rate:

Main Dial: 10Mcs per turn

Mechanical vernier: 1 Mcs per turn

Electrical vernier: ±15kcs

Harmonic Signal

Frequency Range: 75 to 10,000Mcs (all harmonics of fundamental signal up to the 70th)

Signal to Counter

Frequency: Precisely 1 per cent of fundamental frequency (0.75 to 1.5Mcs)

Amplitude: 5v peak-to-peak

Output Impedance: 100 ohms

Beat Frequency Amplifier

Band-width: 1 kcs to 1 Mcs. Equipped with controls to reduce response at high or low end.

Output Signal: 1 v rms out of 1000 ohms.

Built-in Oscilloscope for Displaying Beat Frequency

Size: 2 inches in diameter

Internal sweep: 60cps sine wave with phase control

Characteristics of external sweep signal if used:

Amplitude: 1 v per one inch deflection into high impedance.

Frequency: 20cps to 5kcs.

Power Requirements

117v ±10%, 50 to 60 cps, 170 watts

Dimensions (without cabinet)

8-3/4" high, 19" wide, 18" deep. (Fits into standard 19-inch relay rack)

Other Features

Preset digital dividers expand gate time of associated counter by any factor from 1 to 100.

Built-in mechanical analog computer calculates harmonic number of all harmonics from the 9th to the 70th.

2. OPERATION

2.1 INSTALLATION

Both the transfer oscillator (Model 7580) and the frequency counter (Model 7360J) may be mounted in a standard 19-inch relay rack. After mounting, make the following interconnections, using the cables provided.

1. Connect FREQUENCY OUT jack on the transfer oscillator to the A INPUT jack on the counter with a coaxial cable. This cable delivers the frequency which the counter will actually count.
2. Connect the TIME jack on the counter to the TIME BASE INPUT jack on the transfer oscillator. This couples clock pulses to preset dividers in the transfer oscillator.
3. Connect the B CHANNEL jack on the transfer oscillator to the B INPUT jack on the counter. This couples "start counting" and "stop counting" pulses from the preset dividers to the counter. The interval separating the pulses will be the clock pulse interval multiplied by the harmonic number to which the preset dividers are set.
4. Connect the ACCESSORY jack on the counter to the ACCESSORY jack on the transfer oscillator using the multi-conductor cable supplied. This cable delivers certain d-c supply voltages to the transfer oscillator.
5. Connect the 117V AC connector on both units to a source of line power, (117v ± 10 per cent, 60 cps). The counter draws 325 watts, the transfer oscillator, 170 watts.

Mount tuning stubs on both front-panel jacks marked TUNE. These stubs should be in place except when measuring frequencies below 150Mcs.

The unit is now ready to operate.

2.2 INPUT REQUIREMENTS

2.21 Frequency Range. The assembly (counter plus transfer oscillator) will measure an extremely broad range of frequencies.

10,000 to 500Mcs

Measured using standard operating procedure. Operator need not know approximate frequency. Harmonic calculator on transfer oscillator will indicate harmonic number.

500 to 150Mcs

Measured using standard operating procedure except operator must make simple arithmetic computation to find harmonic number. Operator need not know approximate frequency.

(Continued on page 7)

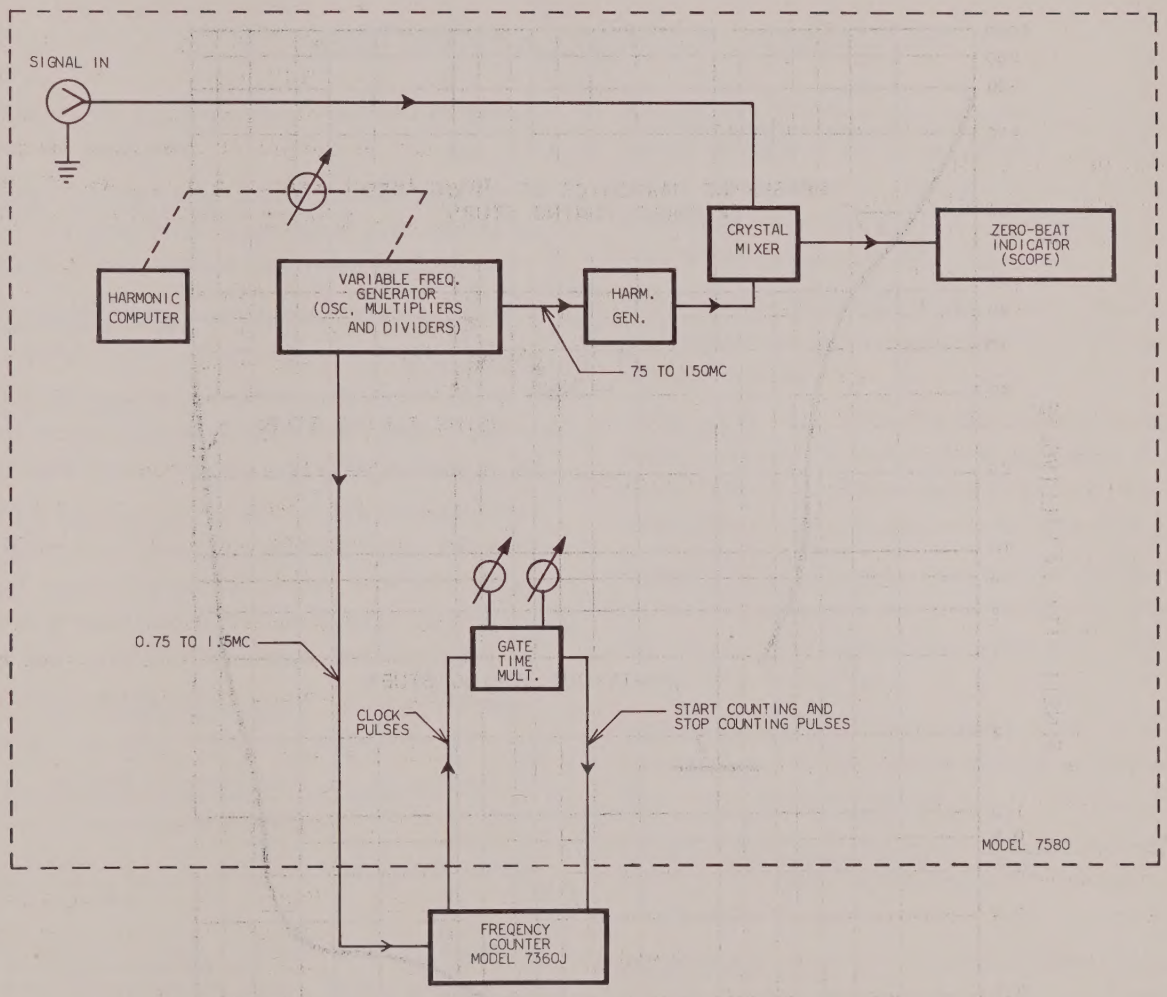


FIGURE 1. SIMPLIFIED BLOCK DIAGRAM

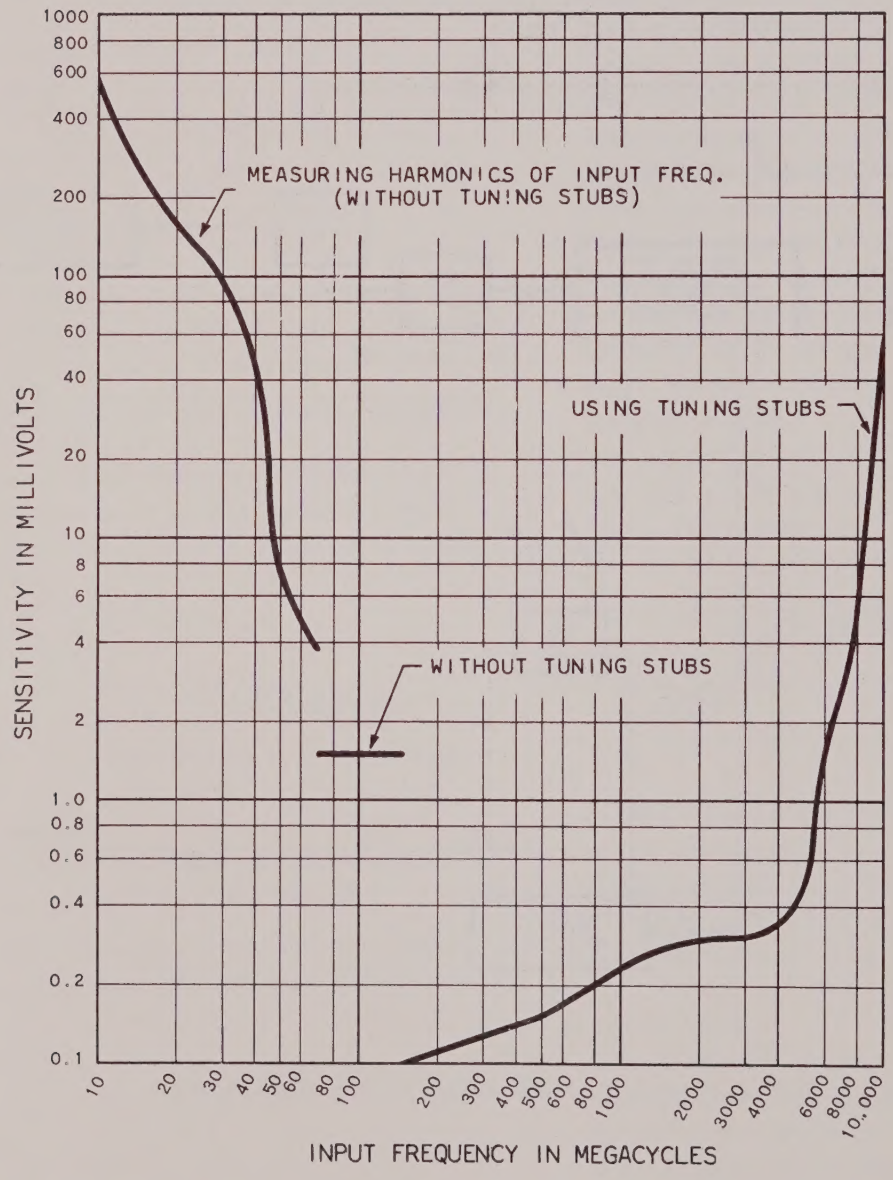


FIGURE 2. TYPICAL SENSITIVITY CURVE

TABLE 1

OPERATING CONTROLS, CONNECTORS AND INDICATORS

POWER switch and indicator. Applies line power to transfer oscillator.

Two-inch oscilloscope. Displays difference frequency resulting from input signal beat against a harmonic of the transfer oscillator fundamental.

VERT GAIN control. Increases vertical gain of scope when turned CW.

HIGH FREQ control. Decreases high frequency response of scope when turned CCW. High frequency cut-off (6db down) may be varied from 1Mcs to 1Kcs.

LOW FREQ control. Increases low frequency response of scope when turned CCW. Low frequency cut-off (6db down) may be varied from 250Kcs (extreme CW position) to 1000cps (turned CCW to a stop) to 100 cps (twisted CCW until a switch clicks).

INTENSITY & FOCUS controls. Control intensity of trace on scope and focus of cathode ray.

VERT & HORIZ CENTERING controls. Control position of trace on face of scope.

HORIZ GAIN control. Expands trace horizontally when turned CW.

HORIZ PHASE control. Varies phase of 60cps internal horizontal sweep signal. When turned CCW until a switch clicks, the horizontal amplifier is disconnected from the 60cps signal and connected to the EXT SWEEP INPUT jack on the rear panel.

VIDEO OUT jack. The beat frequency signal is available here for an external scope display.

FREQUENCY dial. Adjusts fundamental frequency over range of 75 to 150Mcs. Dial indicates frequency to within ±50Kcs. (See figure 3.)

VERNIER control. Varies fundamental frequency ±15Kcs.

READ HARMONIC knob and indicator. Used to compute harmonic number. (See figure 5 and step 5 under paragraph 2.3.)

HARMONIC NUMBER selector switches. Counting period of counter will be expanded by the factor set on these switches. Switches should be set to number of whatever harmonic is brought to zero beat with input signal. (See figure 3.)

SIGNAL IN jack. Couple signal whose frequency is to be measured to this jack. (See step 3 under paragraph 2.3.)

TUNE jacks. Mount sliding short tuning stubs to these jacks when measuring a signal above 150Mcs. Below 150Mcs terminate these jacks with the 50-ohm dummy load attached to a chain near each jack.

FREQUENCY OUT jack. Signal which the counter measures appears at this jack. The frequency here is 1% of the fundamental frequency. (See step 1 under paragraph 2.1.)

B-CHANNEL jack. "Start counting" and "stop counting" signals for counter appear at this jack (See step 3 under paragraph 2.1.)

117VAC line power connector. Mounted on rear panel. This is the line power input connector. (See step 5 under paragraph 2.1.)

ACCESSORY connector. Mounted on rear panel. Input for certain d-c supply voltages generated in the counter. (See step 4 under paragraph 2.1.)

TIME BASE INPUT jack. Mounted on rear panel. Clock pulses from the counter should be coupled to this jack. (See step 2 under paragraph 2.1.)

EXT SWEEP INPUT jack. Mounted on rear panel. If desired, an external horizontal sweep signal for built-in scope may be introduced at this jack (See paragraph 2.4.)

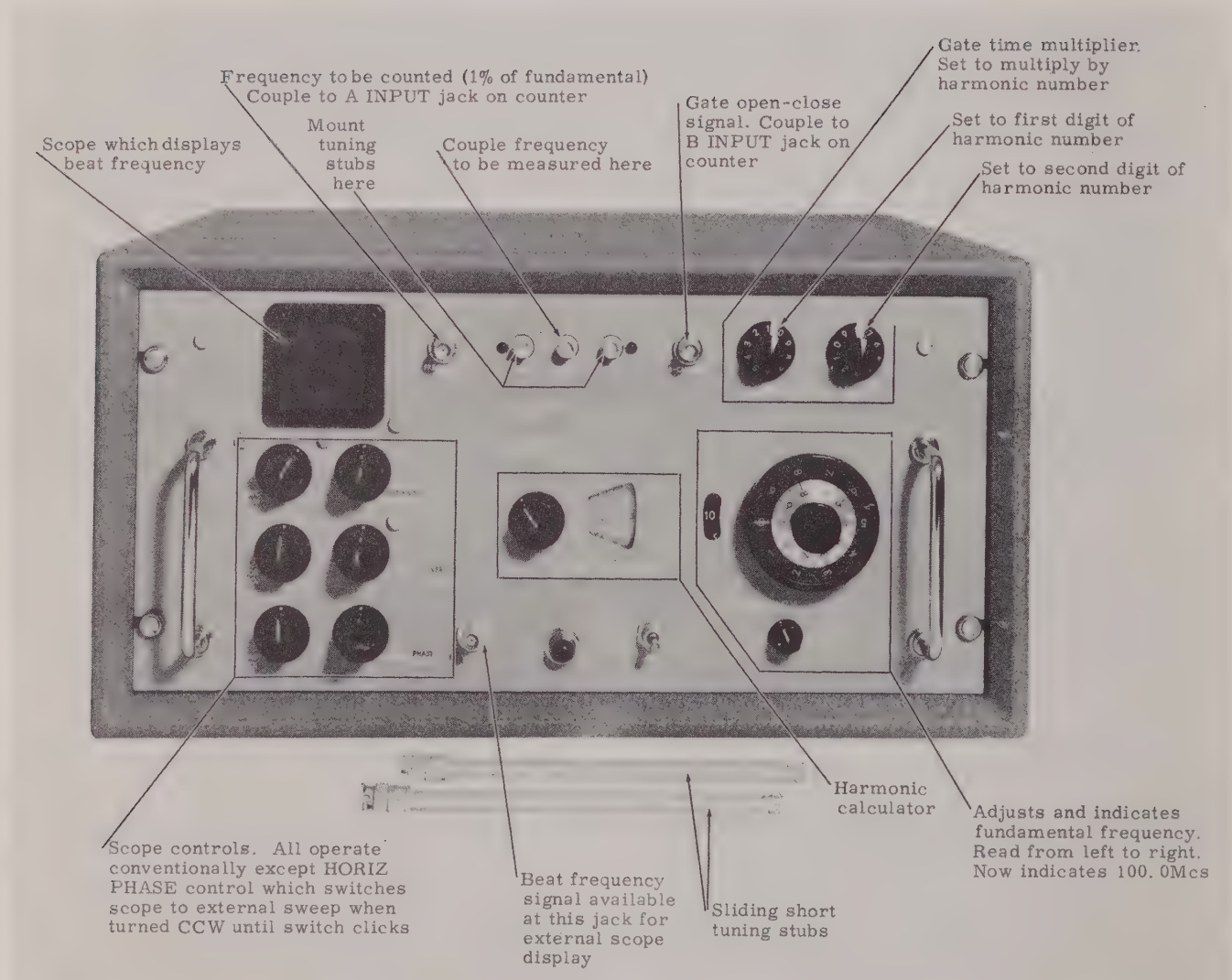

Gate time multiplier. Set to multiply by harmonic number
Frequency to be counted (1% of fundamental) Couple to A INPUT jack on counter
Gate open-close signal. Couple to B INPUT jack on counter
Set to first digit of harmonic number
Mount tuning stubs here
Scope which displays beat frequency
Couple frequency to be measured here
Set to second digit of harmonic number
Harmonic calculator
Adjusts and indicates fundamental frequency. Read from left to right. Now indicates 100. 0Mcs
Scope controls. All operate conventionally except HORIZ PHASE control which switches scope to external sweep when turned CCW until switch clicks
Beat frequency signal available at this jack for external scope display
Sliding short tuning stubs

FIGURE 3. FRONT PANEL OF TRANSFER OSCILLATOR.

150 to 75Mcs

Measured using standard operating procedure excluding calculation of harmonic number, which will always be one. Operator must know that input frequency lies within this range.

75Mcs to 2.1Mcs

May be measured by generating a harmonic above 75Mcs using the mixer crystal of transfer oscillator, then measuring the harmonic by usual techniques. Operator must know approximate frequency.

2.1Mcs to d-c

Measured using frequency counter alone.

2.22 Signal Amplitude. Required signal amplitude varies with frequency. In general, a 100mv signal is more than adequate except when attempting to measure a harmonic of the input frequency. See figure 2 for sensitivity at all points in the frequency range.

2.3 STEP-BY-STEP PROCEDURE FOR MEASURING CONTINUOUS, FIXED-FREQUENCY SIGNALS

1. Apply power to the transfer oscillator and the counter, using the POWER switches on the front panel of each.
2. Adjust the counter for A/B operation as described in the instruction manual on Model 7360J.
3. Couple the frequency to be measured to the SIGNAL IN jack on the transfer oscillator front panel. The input is designed to be driven by a 50-ohm source. See "Input Requirements" for description of appropriate signals.
4. Initial scope control positions.
   a. Position the HORIZ GAIN so that the sweep covers the entire scope field.
   b. Rotate HIGH FREQ and HORIZ PHASE controls fully clockwise.
   c. Rotate VERT GAIN control fully clockwise unless noise covers more than 20 per cent of vertical field range. In this case, back off VERT GAIN until noise is within the 20 per cent limit.
   d. Rotate the LOW FREQ control CW, then back CCW to a stop, but do not twist it until a switch clicks at the CCW extreme.
5. The next step is to locate two adjacent fundamental frequencies both of which produce a harmonic whose frequency equals the input frequency. We will call the higher to the two fundamental frequencies "f_H" and the lower "f_L".
   a. Rotate the large concentric FREQUENCY dial as far clockwise as it will go. Rotate the VERNIER control fully clockwise also.
   b. Locating higher fundamental, f_H.

      Procedure. Rotate FREQUENCY dial slowly CCW, thus reducing the fundamental frequency, until an appreciable signal appears on the scope, turning VERT GAIN control CCW, if necessary, to keep peaks of signal in view. Adjust tuning stubs also for maximum amplitude.

      Explanation. The signal displayed is a difference frequency created by the input signal beat against a harmonic of fundamental frequency f_H. The approximate value of f_H may read on the FREQUENCY dial. It is unnecessary to obtain an exact zero beat at this point in the procedure.
   c. Rotate the HARMONIC indicator knob CCW as far as it will go. The indicator should read infinity (∞).
   d. Locating lower fundamental, f_L.

      Procedure. Be very careful not to turn the FREQUENCY dial clockwise even a little bit at this point; instead, rotate the FREQUENCY dial farther CCW, thus reducing the fundamental frequency further, until another appreciable signal appears on the scope. The amplitude of this signal should be comparable to that observed when locating the higher fundamental. If either signal is less than 1/4 the amplitude of the other, the weaker of the two is probably a spurious response which should be ignored. Adjust the FREQUENCY dial for maximum amplitude, then adjust it carefully to as near zero beat as possible. Turn the HIGH FREQ control CCW as zero

beat is approached to remove obscuring h-f noise from scope display. See figure 4 for typical scope displays near zero beat. With the LOW FREQ control set as directed in step 4d, no frequencies below 1000 cps will appear on the scope. Most input signals will have at least this much frequency deviation, so that it will be unnecessary to see frequencies lower than this in order to reach the best zero beat possible. When dealing with an extraordinarily stable signal, twist the LOW FREQ control CCW until a switch clicks audibly. This extends the low frequency response of the scope to 100 cps. Then, adjust the fundamental frequency to a precise zero beat using the VERNIER control located below the FREQUENCY dial.
Explanation. The signal appearing on the scope is a difference frequency created by a harmonic of f_L beat against the input signal. At zero beat the harmonic equals the input frequency. The FREQUENCY dial indicates the approximate value of f_L.

6. Find the harmonic number of f_H. The harmonic number of f_L is one more than that of f_H. If the HARMONIC indicator knob has rotated steadily as the fundamental was lowered from the higher to the lower frequency, the harmonic number of f_H may be read directly from the HARMONIC indicator. (See figure 5 for directions.) On the other hand, if the knob stops turning before the lower fundamental is reached, the operator must calculate the harmonic number of f_H, using the following formula:

$$\text{Harmonic number of } f_H = \frac{f_L}{f_H - f_L}$$

This calculation will be necessary only when dealing with harmonics below the 9th, so the values of f_H and f_L as read from the FREQUENCY dial are sufficiently accurate to determine the harmonic number, which will be an integer less than 10.

7. Set the HARMONIC NUMBER selector switches to the harmonic number of f_L. For example, if the HARMONIC indicator read "27", the harmonic number of f_L would be 28. In this case, the operator would turn the left-hand switch to "2" and the right-hand switch to "8".
8. Read the frequency indication on the counter front panel. Table 1 shows the proper placement of the decimal point for various TIME and FUNCTION switch positions. For most measurements, it is convenient to place the FUNCTION switch at A/B, and the TIME switch at 10^{-1}. This permits a reading to the nearest kilocycle.

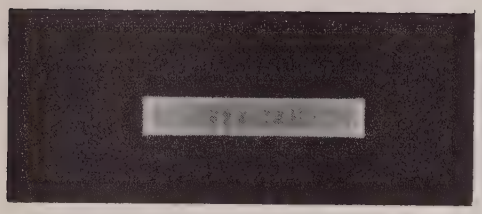
		FUNCTION SWITCH POSITION	
		A/B	A/B X 10
TIME SWITCH POSITION	1	000.0000	X0.00000
	10^{-1}	0000.000	X00.0000
	10^{-2}	00000.00	X000.000
	10^{-3}	000000.0	X0000.00
	10^{-4}	0000000.	X00000.0

Table 1. PLACEMENT OF DECIMAL POINT FOR A READING IN MEGACYCLES. "X" DENOTES A LUCITE PANEL WITH NO ILLUMINATED DIGIT WHATEVER.

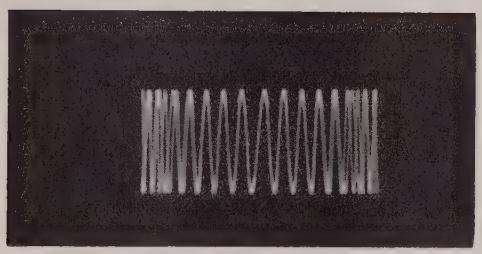
9. Check the frequency reading by returning the FREQUENCY dial to the higher fundamental f_H. This time, adjust the frequency as closely as possible to zero beat. Then set the HARMONIC NUMBER selector to the harmonic number of f_H; that is, reduce the number selected by one. With allowance for accuracy limitations, the counter reading should be the same as the earlier one. If the reading is higher than the first one, the actual harmonic number must be higher than that read on the HARMONIC indicator, therefore, try the next higher HARMONIC NUMBER at both zero beats. The reverse holds true if the check produces a lower reading. When both readings are the same, the harmonic numbers are certain to be correct.

2.4 MEASURING F-M SIGNALS

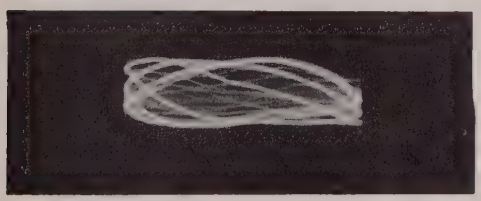
This instrument will measure F-M signals modulated at any frequency from zero to 15kcs. The method is the same as that given for fixed-frequency



A. Display near enough zero beat to produce a visible difference frequency.



B. Display when closer to zero beat than in A above. Individual cycles of difference frequency (now approximately 1000cps) are visible.



C. Display at the best zero beat possible. Input frequency is not absolutely stable; consequently scope shows a part of one cycle of difference frequency as the input frequency wobbles to each side of zero beat. A prefectly stable signal would result in a straight horizontal line at zero beat.

FIGURE 4. SCOPE DISPLAYS NEAR ZERO BEAT WHEN MEASURING A CONTINUOUS SIGNAL WITHOUT FREQUENCY MODULATION

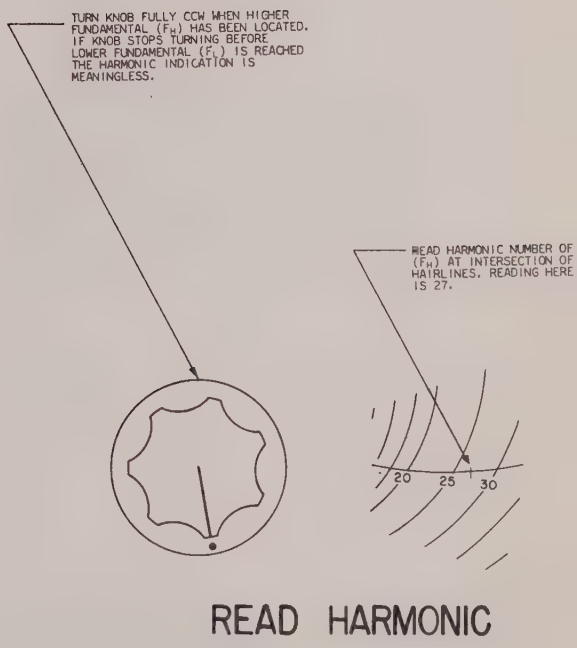

TURN KNOB FULLY CCW WHEN HIGHER FUNDAMENTAL (F_H) HAS BEEN LOCATED. IF KNOB STOPS TURNING BEFORE LOWER FUNDAMENTAL (F_L) IS REACHED THE HARMONIC INDICATION IS MEANINGLESS.
READ HARMONIC NUMBER OF (F_H) AT INTERSECTION OF HAIRLINES. READING HERE IS 27.
20
25
30
READ HARMONIC

FIGURE 5. HOW TO FIND HARMONIC NUMBER

signals except that the built-in scope must be swept by a signal of the modulating frequency. If the input signal is modulated at the line frequency, no external sweep need be supplied because scope is swept by this frequency under ordinary operation. If the modulating frequency is other than 60 or 120 cps, couple a signal of the modulating frequency to the EXT SWEEP INPUT jack and turn the HORIZ PHASE control CCW until a switch clicks audibly.

The scope displays near zero beat will resemble those pictured in figure 6. The input frequency will pass through zero beat twice during each sweep cycle. These points appear as regions of minimum frequency on the face of the scope. With the horizontal sweep phase adjusted properly, the two zero beat points will be coincident. If the LOW FREQ control is turned fully CCW until a switch clicks, frequencies as low as 100 cps will appear on the scope, permitting the operator to locate the zero-beat point with maximum precision.

It is possible to measure the approximate frequency deviation of a signal by varying the FREQUENCY dial until the zero-beat point appears first at one end, then at the other end of the sweep span. The frequency deviation will then be the difference between the indicated frequency at each extreme. The center frequency will be that indicated with the zero-beat point at the middle of the sweep.

2.5 MEASURING PULSED SIGNALS

The instrument will measure the carrier frequency of pulses as narrow as one microsecond. With the following exceptions, the procedure is the same as that used for measuring continuous signals:

1. The beat frequency must be displayed on a separate oscilloscope which is synchronized to begin each sweep when, or slightly before, each pulse occurs. To do this, couple the VIDEO OUT jack to the scope input and trigger the scope with a signal synchronized with the occurrence of pulses.
2. Turn HIGH FREQ control fully CW and LOW FREQ control fully CCW to obtain broadest possible video frequency range.
3. Near zero beat the scope pattern will be similar to those shown in figure 7. Adjust the frequency control for a group of parallel lines as nearly horizontal as possible.

2.6 ACCURACY

The possible error of any measurement depends upon:

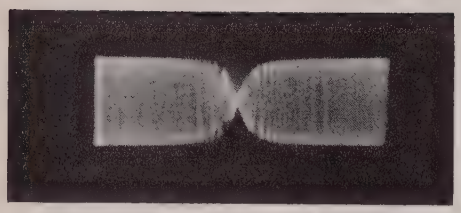
1. The counting resolution of the counter taken in conjunction with the gate time.
2. How close to zero beat the harmonic can be adjusted.
3. The stability of the fundamental frequency.
4. Accuracy of clock signal from the counter.

To take an ideal example, suppose the input were a perfectly fixed frequency of 4000Mcs. In this case, the fundamental frequency would be adjusted to 100 Mcs and the 40th harmonic brought to zero beat with the input frequency. The counter would count cycles of a 1 Mcs signal over a period of 4 seconds (0.1 secs times 40). The possible error of this measurement is the sum of three errors:

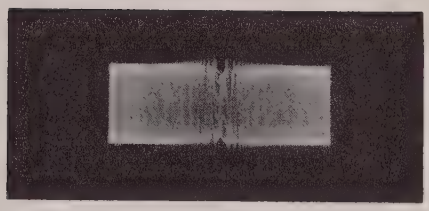
1. ±1000cps -- due to possible counting erro of ±1 count. With the counter TIME switch at 10^{-1} each count represents 1000 cycles.
2. ±100cps -- due to possible inaccuracy in zero beat setting. Beat frequencies below 100cps are not observable on the scope.
3. ±1 part in 10^7 -- stability of fundamental frequency over a 10-second period.
4. ±2 parts in 10^7 -- possible error of clock signal generated by Model 7360J counter.

Summing these possible errors, we get 1100cps (3 parts in 10^7) plus 1 part in 10^7 plus 2 parts in 10^7 which is approximately 7 parts in 10^7. If we try to decrease the counting error by increasing the gate time from 4 to 40 seconds, the improvement is offset by an increase in frequency drift of the fundamental over the longer period.

Additional error is introduced when the input signal varies in frequency. If it varies slowly, a skillful operator can track the signal by varying

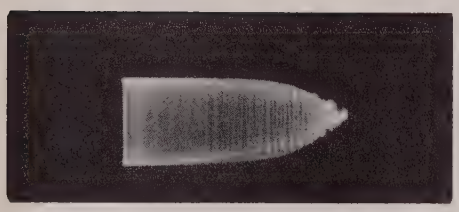


Low Freq cut-off: 1000cps

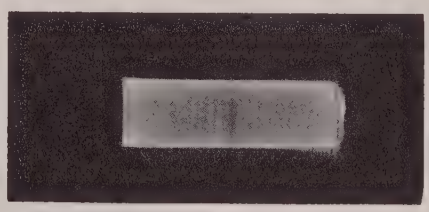


Low Freq cut-off: 100cps

A. Scope display with zero beat at center frequency.

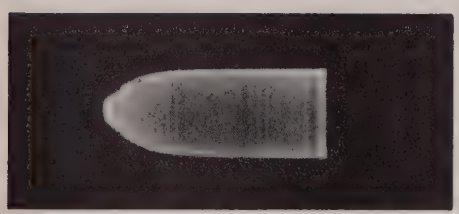


Low Freq cut-off: 1000cps

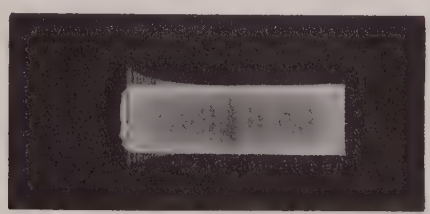


Low Freq cut-off: 100cps

B. Scope display with zero beat at one extreme of frequency deviation.



Low Freq cut-off: 1000cps



Low Freq cut-off: 100cps

C. Scope display with zero beat at opposite exterme of frequency deviation

FIGURE 6. SCOPE DISPLAYS NEAR ZERO BEAT WHEN MEASURING AN F-M SIGNAL. CENTER FREQUENCY OF INPUT SIGNAL CAUSING THESE DISPLAYS IS ABOUT 4000MCS; FREQUENCY DEVIATION, ABOUT 30MCS.

the fundamental frequency to maintain an approximate zero beat at all times during the 4-second counting period. In this case, the reading will be an average frequency over the 4-second period. If the input frequency wobbles back and forth so rapidly that it cannot be tracked, the reading will simply be the frequency at some point in the frequency swing.

3. CIRCUIT DESCRIPTION

3.1 Oscillator and Multiplier Chain. The fundamental frequency is developed by an oscillator and a chain of frequency multipliers. The oscillator (V801) generates a signal whose frequency may be varied from 1.5 to 3Mcs. This signal drives a chain of three frequency multipliers (V302 thru V304) which, taken together, multiply the oscillator frequency by 50, producing a fundamental frequency which varies from 75 to 150Mcs at the same time that the oscillator is varied over its frequency range. The oscillator and the frequency multipliers are gang-tuned.

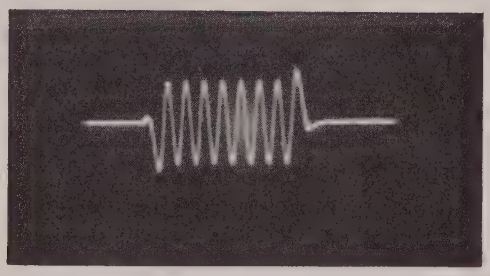
3.2 Mixer and Beat Frequency Indicator. The fundamental signal drives a crystal diode which generates harmonics up and above the 70th. These harmonics are then mixed with an input signal in another crystal diode, producing a multitude of difference frequencies. The output of the diode is amplified by the first video amplifier (V201) then fed through a low pass filter which blocks all frequencies above 1.5Mcs. This removes all frequencies except the comparatively low beat frequency produced by the input frequency and a harmonic nearly equal to the input frequency. This beat signal is amplified by several video stages (V202 thru V204) then applied to the vertical deflection plates of a small CRT, where it may be observed. The beat signal is also available at the VIDEO OUT jack.

The horizontal sweep for the CRT is a 60cps sinusoidal signal, derived from the power supply transformer and amplified by V205. Both the amplitude and phase of this signal are adjustable. The horizontal sweep may be supplied by an external signal coupled to the EXT SWEEP INPUT jack.

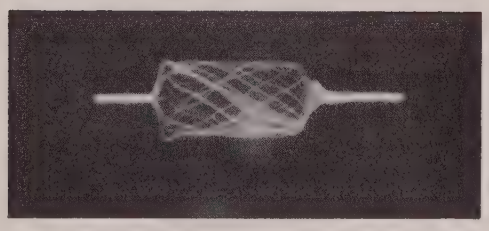
3.3 Oscillator Binary. The oscillator signal is also fed through a shaper (V403) to a binary (V404) which divides its frequency by two. Since output of the binary is one half the oscillator frequency whereas the output of the multiplier chain (the fundamental) is 50 times the oscillator frequency, the binary produces a frequency exactly 1/100 of the fundamental frequency. This makes it possible to monitor the fundamental frequency by feeding the output of the binary to the electronic counter.

3.4 Time Base Multiplier. The electronic counter ordinarily counts for 0.1, 1.0 or 10 seconds, the counting period being determined by the interval between the clock pulses it generates. Operated in this way, it would register the fundamental frequency of the transfer oscillator. However, when used in this system, the counter delivers clock pulses to a circuit in the transfer oscillator which multiplies the interval between pulses by the number of whatever harmonic has been brought to zero beat with the input frequency. This circuit (called the time base multiplier) contains two cascaded decimal counting units which count clock pulses and are capable of delivering an output signal at any preset number of counts from 1 to 99. The operator sets these units to the number of the harmonic. If the harmonic number were 33, for example, the DCU's would count 32 clock pulses then open a diode gate, allowing the 33rd pulse to reach the counter and start the counting period. The 33rd pulse, amplified by V402, also resets the two DCU's, which close the gate and begin counting clock pulses again. Thirty three clock pulses later, another pulse reaches the counter to terminate the counting period. In this way, the counting period is multiplied by 33 so that the counter will indicate a number 33 times the fundamental frequency, or, in other words, the frequency of the 33rd harmonic.

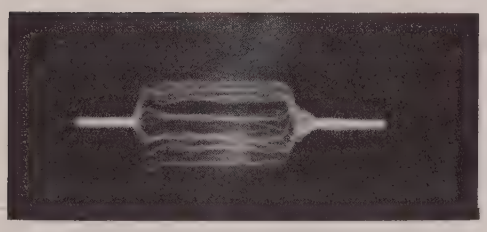
3.5 Harmonic Calculator. To use the harmonic calculator it is necessary to locate two adjacent fundamental frequencies each of which produce a harmonic equal to the input frequency. If we call the two fundamentals f_H (higher fundamental) and f_L (lower fundamental), the harmonic calculator



A. Display when near enough to zero beat to see how many cycles of the difference frequency signal occur during the period of one pulse.



B. Display when closer to zero beat than A, above.



Display when as near zero beat as possible. At perfect zero beat the display would be a group of straight horizontal lines. Irregularities in this display are caused by an input signal wh ich varies slightly in frequency, as nearly all signals do.

FIGURE 7. SCOPE DISPLAYS NEAR ZERO BEAT WHEN MEASURING A PULSED R-F SIGNAL

solves the equation.

$$n = \frac{f_L}{\Delta f}$$

where $\Delta f = f_H - f_L$

n = harmonic number of f_H

The rotating scale of the calculator is turned manually to the end of the scale at a time when the transfer oscillator is tuned to f_H. Then the scale is allowed to rotate, geared to the FREQUENCY dial, while the dial is moved to f_L. The angular displacement of the scale corresponds to Δf, thus entering this term of the equation. The vertical crosshair superimposed on the scale takes a position corresponding to the fundamental, which at this time is f_L, the other term of the equation. The two terms are combined by reading the value from the scale at the point where the vertical crosshair lies.

4. SERVICING

4.1 Adjusting the Multiplier Chain. Ordinarily, the frequency multipliers will require adjustment only when tubes have been replaced. At that time it may be necessary to adjust the trimmer capacitors in the parallel tuned circuits of each stage to compensate for stray tube capacitance. All trimmer capacitors and test points are located on the top of the multiplier chassis and identified by a detail number stamped on the chassis. See "Schematic Diagram, Oscillator and Multiplier Chain" for a diagram of the circuit being adjusted. When measuring a d-c voltage use a VTVM with an input resistance of 10 megohms or more. Proceed as follows: (1) adjust the fundamental frequency to about 150Mcs. (2) adjust capacitors C308 and C315 for a maximum d-c voltage between test point E302 and ground. (3) adjust C317 and C321 for maximum d-c voltage between test point E303 and ground. (4) disconnect J303 from the front panel, couple a 50-ohm load to J303 and adjust C325 and C338 for a maximum r-f voltage across the 50-ohm load. (5) make a final adjustment of all six trimming capacitors for maximum a-c voltage across the 50-ohm load. (6) remove 50-ohm load and reconnect J303 to the front panel.

4.2 Adjusting the Positive D-C Supply. Adjust the +225V ADJUST control (located and identified on top of the proper supply chassis) for +225 volts ±2 per cent with respect to ground at pin 6 of V103.

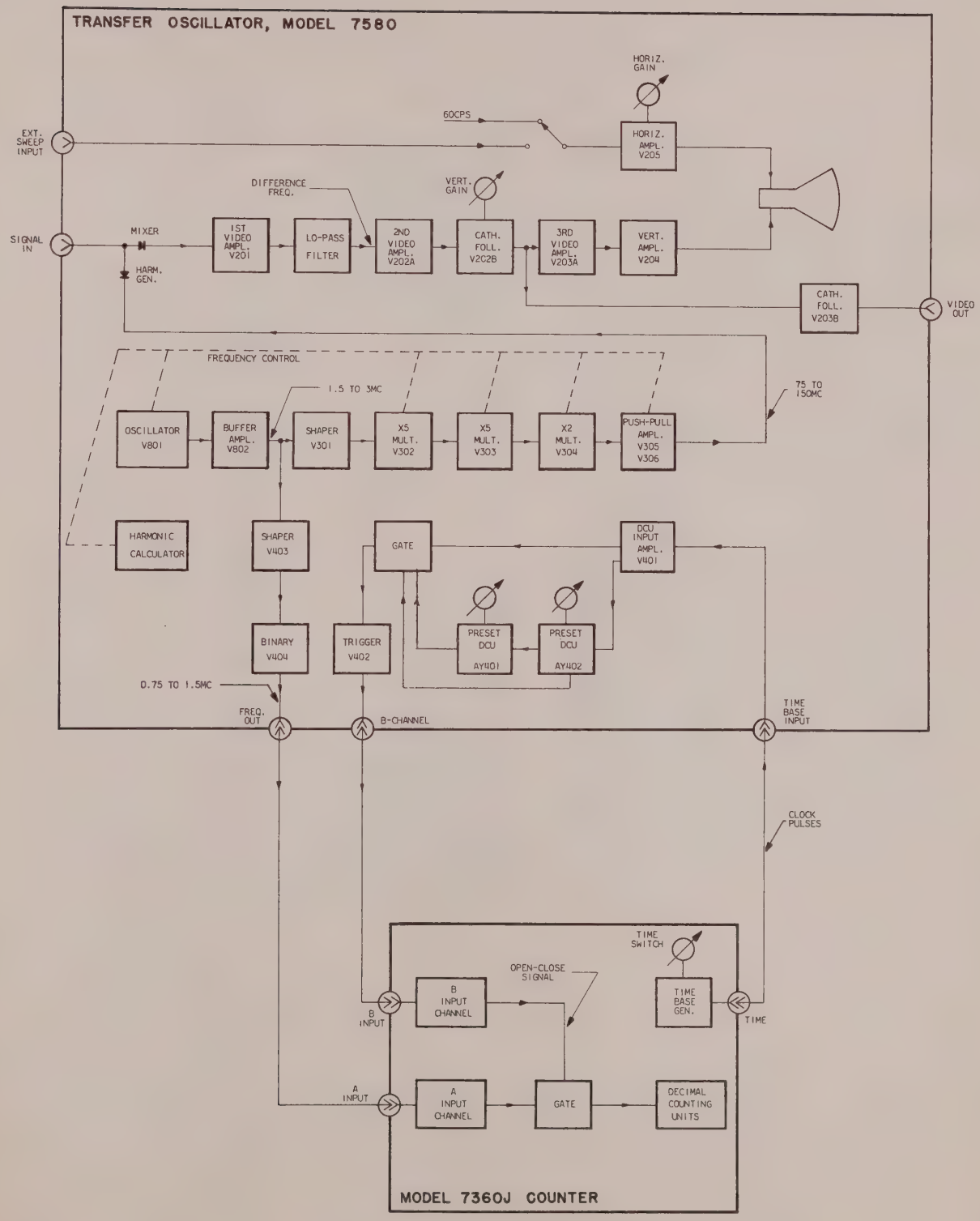


FIGURE 8. BLOCK DIAGRAM OF MODEL 7580

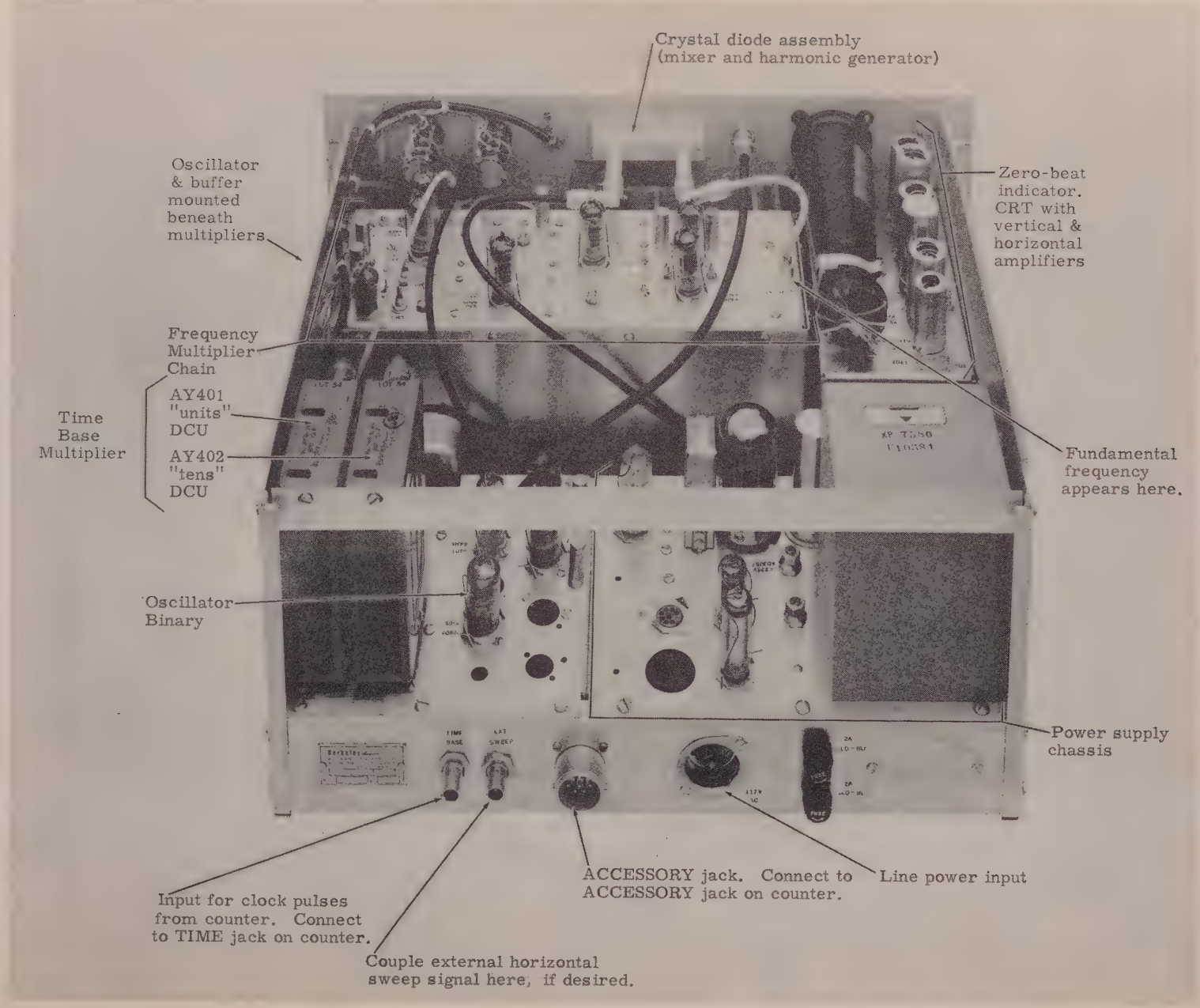
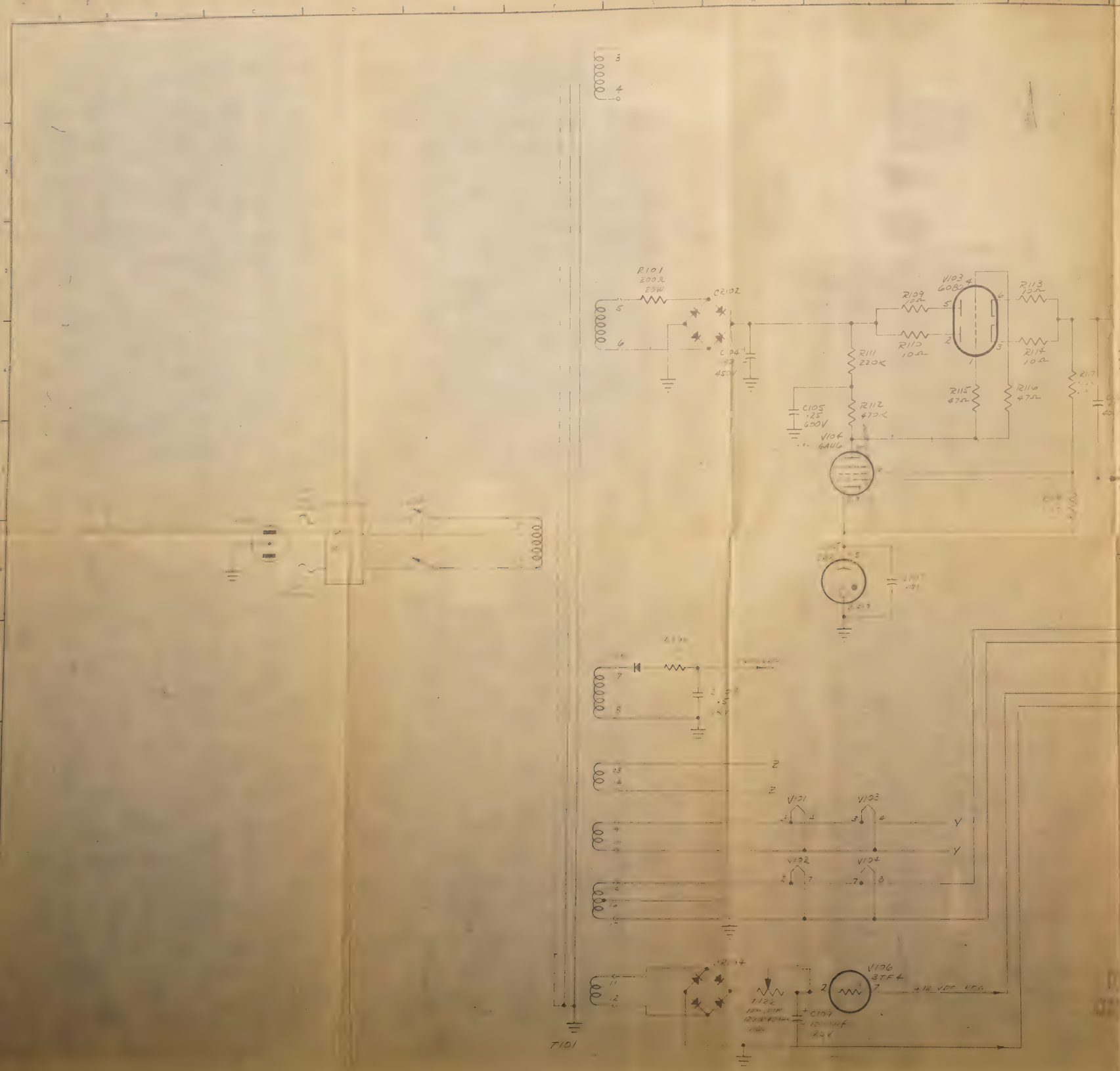


FIGURE 9. INTERIOR VIEW OF TRANSFER OSCILLATOR



NOTE:

RESISTORS:
WATTAGE — ½W UNLESS OTHERWISE NOTED
TOLERANCE — 10% UNLESS OTHERWISE NOTED.

CERAMICS:
CAPACITY — VALUE IN MFD UNLESS OTHERWISE NOTED.

REF	STK OR DWG No.	ITEM AND DESCRIPTION	QTY		
MATERIAL				UNLESS SPECIFIED: DIMENSIONS IN INCHES	
FINISH				TOLERANCES: FRACTIONAL ± 1/64 DECIMAL ± .005 ANGULAR ± 30'	
MODEL	NEXT ASSY				
DRAWN RM	DATE 7-11-57				
CHECKED JM	DATE 7-11-57	Beckman / Berkeley Richmond, California			
CHECKED	DATE				
APPROVED	DATE			SCALE:	
USE	DRAWING No.	POWER SUPPLY SCHEMATIC 7580 D 1			REV

MIXER ASSEMBLY

1 ST. VIDEO AMPL.

2 ND. VIDEO AMPL.

LO-PASS FILTER

CATHODE FOLLOWER

HORIZ. AMPL.

3 RD. VIDEO AMPL.

VERT. AMPL.

VIDEO OUTPUT CATHODE FOLLOWER

+225 VDC REG.

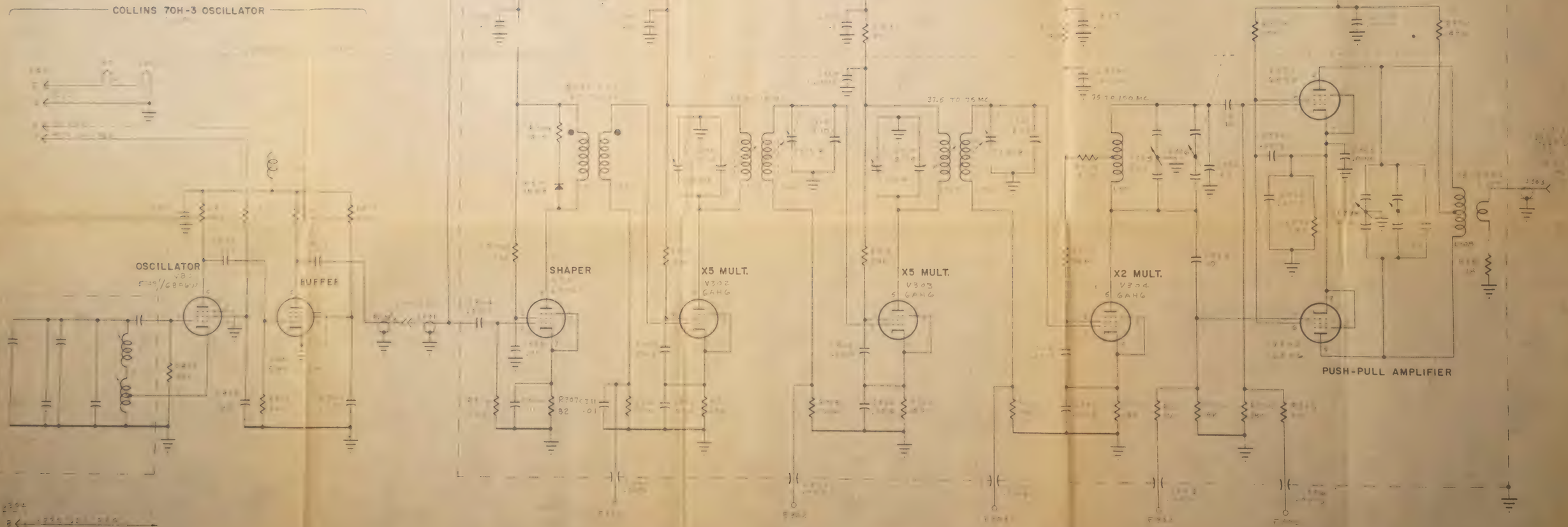
VIDEO OUT

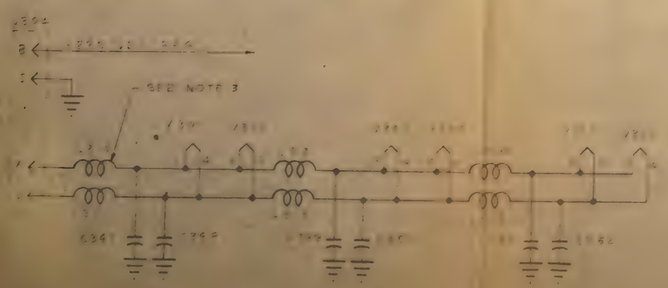
CONFIDENTIAL

Beckman® / Berkeley
Richmond, California

COLLINS 70H-3 OSCILLATOR

MULTIPLIER CHAIN





NOTES:

K = KILOHMS

REF	STK OR DWG No	ITEM AND DESCRIPTION	QTY

MODEL 7580	NEXT ASSY	MATERIAL	UNLESS SPECIFIED DIMENSIONS INCHES
DRAWN	DATE	FINISH	TOLERANCES: FRACTIONAL ± 1/64, DECIMAL ± .005, ANGULAR ± 1/2°
CHECKED	DATE	Beckman® / Berkeley Richmond 5, California	SCALE:
APPROVED	DATE		DRAWING No 7580 D 3 REV
APPROVED	DATE		

REV.	ZONE	DESCRIPTION	APPROVED	DATE

DCL INPUT AMPLIFIER

V401 6AH6

R402 22K

R403 1K

C402 .001

-110 VDC

+190 VDC

X A Y 4 0 4

COUNTING UNIT

CR401 HD6064

CR402 HD6064

CR403 HD6064

CR404 HD6064

+190 VDC

-110 VDC

X A Y 4 0 2

COUNTING UNIT

CR409 HD6064

CR410 HD6064

CR411 HD6064

+190 VDC

R416 1.2K

V402 5965

+120 VDC

R405 15K

C406

R422

R423

RESET SIGNAL

C414 1N67A

C411 .001

SHAPER V403 6CB6

REF.	STK. OR DWG. No.	ITEM AND DESCRIPTION	QTY.
		MATERIAL	
		FINISH	
MODEL	NEXT ASSY.		
DRAWN	DATE		
CHECKED	DATE		
CHECKED	DATE		
APPROVED	DATE		
APPROVED	DATE		

UNLESS SPECIFIED: DIMENSIONS - INCHES
DEC. TOLERANCES:
X — ± .050
XX — ± .020
XXX — ± .005
ANGULAR — ± 1/2°
SURFACE — ▽

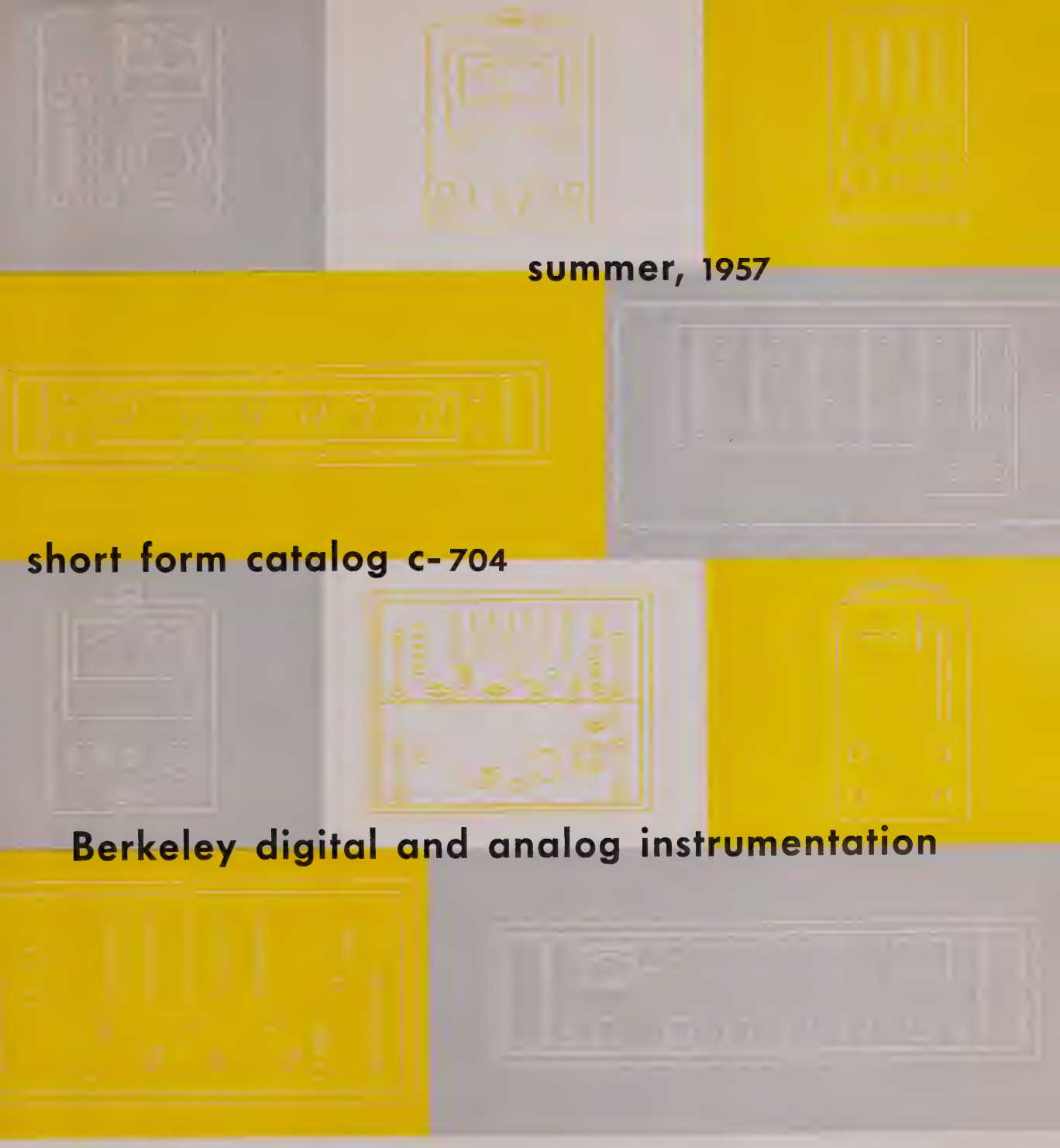
SCALE:

Beckman® / Berkeley
Richmond 3, California

TITLE

DRAWING No. 7-32 D 4

REV.



summer, 1957

short form catalog c-704

Berkeley digital and analog instrumentation

COUNTING, TIMING, FREQUENCY MEASURING EQUIPMENT

• EPUT® Meters • Universal EPUT® Meters • Frequency Measuring Equipment • Preset Counter Controllers • Time Interval Meters • Electronic Counters • Nuclear Scalers and Count Rate Meters • Digital Recorders • Inline Readouts • Transducers • Decimal Counting Units

SPECIAL AND GENERAL PURPOSE TEST INSTRUMENTS

• Expanded Scale Volt Meters • Expanded Scale Frequency Meters • Resistance Bridges • Double Pulse Generators

*EASE** ANALOG COMPUTERS AND *EASE** PRECISION COMPONENTS FOR CONTROL SYSTEMS

*T.M.

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Beckman/Berkeley Division, now in its second decade, supplies industry and science throughout the world with two hundred types of electronic counting, control and computing equipment.

An organization of highly skilled and experienced engineers, designers and production workers, Berkeley is equipped to mass produce a wide range of instruments for science and industry. Techniques for the mass production and assembly of high speed counters, timers and frequency measuring equipment originated at Berkeley.

Facilities at Berkeley are by no means limited to quantity production of standard type instruments. The Engineering Department conducts research development and product design operations in four major fields of electronic interest—counting, timing, and frequency measuring equipment, analog computers, nuclear test instruments and special products.

Naturally this stress on research and development has resulted in important electronic "firsts" at Berkeley. Some of these include:

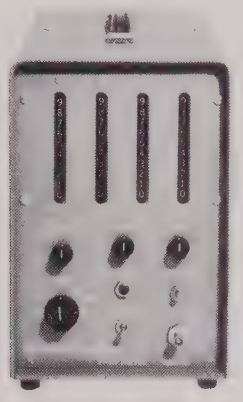
The first 1,000,000 count per second events-per-unit-time meter (EPUT®)
The original electronic decade unit (DCU)
The first direct reading time interval meter for measuring time intervals to one microsecond.
The first console style push-button analog computer (EASE*)
The first direct reading frequency meter
The first digital recorder with printed readout
The first in-line, in-plane digital indicator
The FERRISTOR*, miniature vacuum tube replacement

EPUT® meters

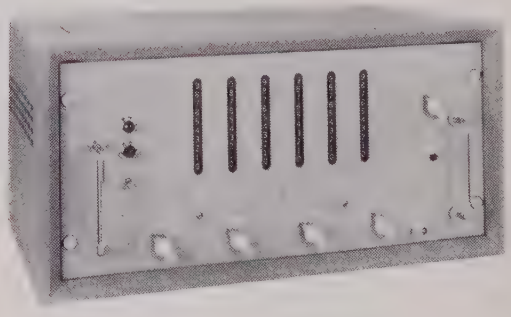
Berkeley EPUT® Meters automatically count and display the number of events that occur during a precise time interval. Events may be any physical occurrences that can be represented by changing voltages occurring either regularly or at random rates to 1,000,000 per second.

APPLICATIONS

Precision tachometry; measurement of pressure, flow, temperature, viscosity, velocity, frequency, frequency period; process control or data reduction systems; calibration of frequency generating equipment; measurement of any electrical, mechanical, optical or other physical event occurring during a precise time interval.

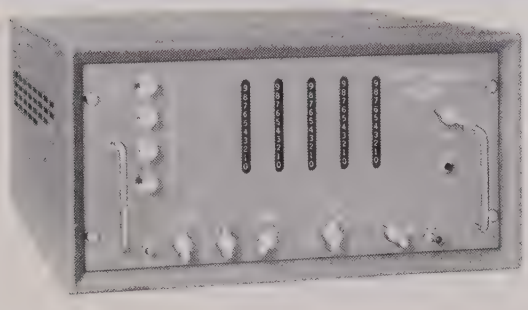


New Model 5210 100 KC EPUT® Meter for industrial and field application. Light, small, portable. Simple to operate. Straightforward design and construction. Reliable. The 5200 Series use same DCUs as other Berkeley equipment.



7000 Series units may be used to measure frequency or period, and also as high speed electronic counters with manual on-off control. Model 7160 shown.

BRIEF SPECIFICATIONS	Model 5210	Model 7150	Model 7151	Model 7160	Model 7161	Model 7650
Count Capacity:	4 digits	5 digits	5 digits	6 digits	6 digits	5 digits
Count Rate:	0 cps to 100 KC	0 cps to 100 KC	0 cps to 100 KC	0 cps to 1 mc	0 cps to 1 mc	0-40,000 cps
Time Bases: (decade steps)	0.1 and 1 sec	10 μsec to 1 sec	Time Interval Generator	1 μsec to 1 sec	Time Interval Generator	0.1 to 10 sec
Binary coded output to drive digital printer	optional $30.00 extra	yes	yes	yes	yes	yes
Price:	$475.00	$775.00	$1195.00	$995.00	$1345.00	$1495.00



New Models 7151 and 7161 Preset EPUT® Meters feature a variable time base. Time base dividers have been replaced by preset DCUs. In addition to specifications below, these instruments feature several unique operating functions: Totalize — divides frequency between 0 and 10 KC by any number from 1 to 10,000; TIG — generates frequencies from 0.1 to 10^4 milliseconds.

*T.M.

Model 7650 Long Life Magnetic EPUT® Meter performs the same function as models described above. Uses Berkeley FERRISTORS* in all critical circuits to assure continuous-duty reliability. Ideally suited to industrial test applications such as jet and piston-engine test cells, etc. Has digital "count-down" time base for precise gating; no adjustment of time base required.

Universal EPUT® Meters

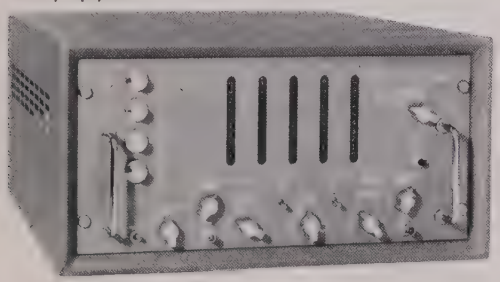
These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT® meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

APPLICATIONS

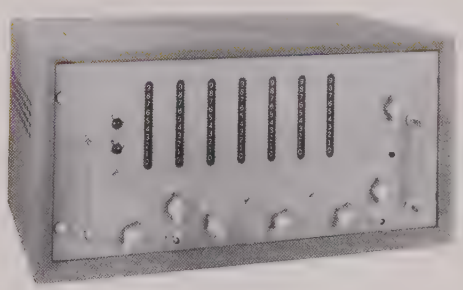
Counting, time interval, events-per-unit time measurements for precision tachometry, measurement of pressure, flow, frequency, velocity, viscosity, elasticity; timing relay, shutter action, etc. Measurement of unknown frequencies, frequency ratios, periods, etc.

BRIEF SPECIFICATIONS	Model 5230	Model 7350	Model 7351	Model 7360	Model 7361
Ranges-Frequency:	0 cps to 100 kc	0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc
Time Interval:	100 μsec to 10^4 sec	10 μsec to 10^6 sec	10 μsec to 10^2 sec	1 μsec to 10^7 sec	10 μsec to 10^3 sec
Period:	0 cps to 10 kc	0 cps to 100 kc	0 cps to 10 kc	0 cps to 1 mc	0 cps to 10 kc
Time Bases:	0.1 and 1 sec	10 μsec to 10 sec	Time Interval Generator	1 μsec to 10 sec	Time Interval Generator
Binary coded output information for driving digital recorder	$30.00 extra	yes	yes	yes	yes
Price:	$575.00	$945.00	$1295.00	$1245.00	$1445.00

New Model 5230 100 kc Universal EPUT® Meter for industrial and field application. Light, small, portable. Simple to operate. Straightforward design and construction. Reliable. The 5200 Series uses same DCUs as other Berkeley equipment.

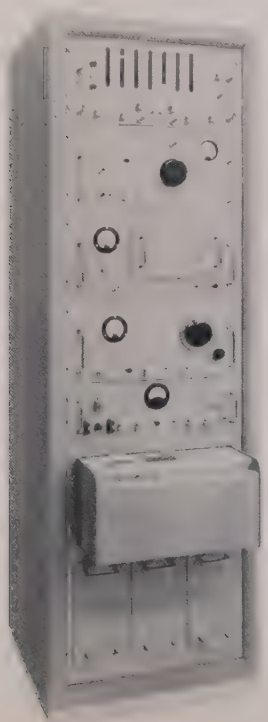


New Models 7351 and 7361 Preset Universal EPUT® Meters features are similar to Models 7150 and 7160 with variable time base feature, etc. In addition, TIM and A/B functions are offered.



Model 7360 Universal EPUT® and Timer.

Frequency Measuring Equipment



Basic instrument is the Model 5571, capable of measuring frequencies from 0 cps to 42 mc. Addition of the Model 5580 UHF-VHF converter and suitable plug-ins extends the range to 515 mc; Model 5582B VHF converter with plug-ins extends the range to 1,005 mc. Results are displayed in direct-reading digital form. Unit will drive a Model 1452 digital printer to provide a complete frequency logging system in which results are printed on standard adding machine tape. Model 5571 is also a Universal EPUT® Meter with same specifications as Model 7360.

New Model 905 WWV receiver is most convenient, reliable method of utilizing standard time and frequency broadcasts from NBS stations WWV and WWVH. Features: covers all six WWV and WWVH frequencies, crystal controlled, separate crystal for each channel, built-in audio filters. Price: $525.00 (Rack) $550.00 (Cabinet).

Complete frequency logging system for frequencies to 1,000 mc. Model 5571 (with 5582B converter and plug-ins), drives Model 1452 digital printer to record results automatically on adding machine tape, 905 WWV receiver.

Model 5571 with 5580 converter and 5580 series plug-ins for frequencies to 515 mc. Model 5571 price, $1825. Model 5580 converter, $300.00. 5581 series plug-ins, $125.00 to $175.00 each. All are FCC-approved. Model 5571 shown.

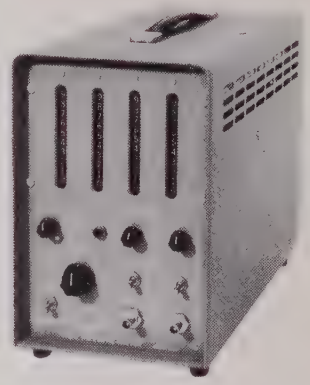
Time Interval Meters

Any event delineated by varying voltages may be timed. All models may be standardized against WWV or other external standards. Provisions are also made to measure period of input signals, use as a high-speed electronic counter, or frequency ratio meter.

APPLICATIONS

Timing of relays, shutters, solenoids, controls; ballistics research; measurement of viscosity, elasticity, velocity; accurate low frequency and period measurements, frequency ratio measurements, etc.

BRIEF SPECIFICATIONS	Model 5220	Model 7250	Model 7260
Range:	100 μsec to 1 sec	10 μsec to 1 sec	1 μsec to 1 sec
Accuracy:	± 100 μsec ± 1 part in 10^4	± 10 μsec, ± 1 part in 10^5	± 1 μsec, ± 1 part in 10^6
Input Requirements:	0.25v rms, 1 megohm dc-coupled.	0.1v rms, 10 megohms, ac or dc-coupled.	
Display Time:	Adjustable .05 to 5 sec.	Adjustable, 0.1 to 10 seconds (automatic reset). Manual reset also provided.	
Binary-coded output to drive Digital Printer	Optional $30.00 extra	yes	yes
Price: (f.o.b. Factory)	$475.00	$595.00	$830.00



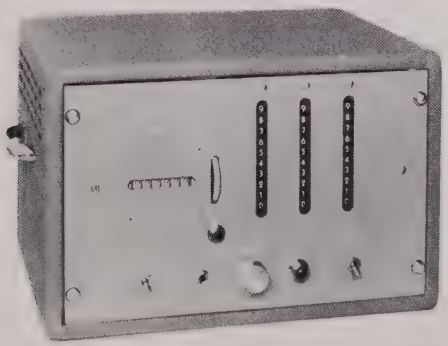
New Model 5220 100 μsec to 1 sec time interval meter for industrial and field applications.

Model 7250 Berkeley Time Interval Meters provide a direct digital reading of elapsed time between any two events, or the duration of a single event, in microsecond (Model 7260) or 10-microsecond increments.

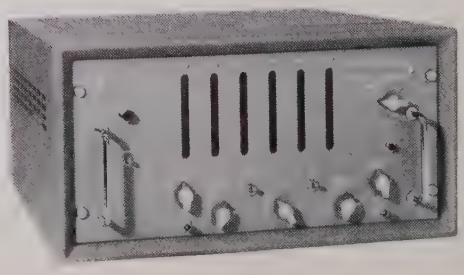
Electronic Counters

BRIEF SPECIFICATIONS	Model 5001	Model 5010	Model 7050	Model 7060
Counting Rate:	0-125 cps	0-10,000 cps	0-100KC	0-1 mc
Sensitivity:	0.5 volts peak	0.5 volts peak	0.1 volts rms.	0.1 volts rms
Binary coded output to drive Digital Printer	no	no	yes	yes
Price:	$195.00	$330.00	$545.00	$645.00

Model 5001 (125 cps) industrial type electronic counter for use where speed requirements are in excess of the limitations on mechanical registers (10 cps).



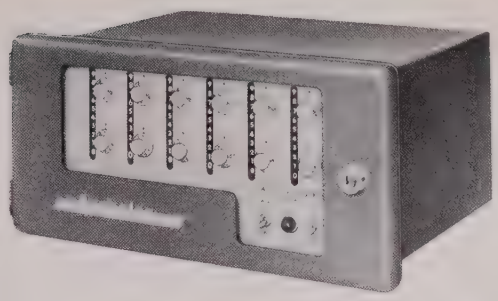
The Berkeley Industrial Counter, Model 5010 (10 KC), is a highspeed electronic counting instrument designed to fill general counting needs, where speed requirements are greatly in excess of those possible with mechanical counters.



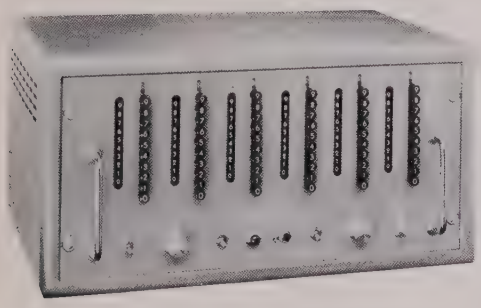
New Models 7050 (100 kc) and 7060 (1mc) gating counters offer both manual and electronic gating. Gate control signals may be of any frequency from d-c to maximum counting rate of the instrument with no input waveform restrictions. For use as frequency ratio meters, digital flow computers, slave EPUT® or time interval meters, high speed counters. Shown Model 7060.

Preset Counter-Controllers

Counts at rates to 40,000 cps, yields output signals at any desired preset total (or any two preset counts with dual preset models). Operates on input pulse of ± 1 volt peak, or more. Instantaneous reset to zero after final count. Reliable, simple to operate. Available in 2, 3, 4, 5, and 6-digit capacities. Long-life magnetic Model 5840 dual preset features FERRISTOR* circuitry for continuous-duty reliability. Typical applications: coil winding, automatic packaging, sorting to length, motor speed control.

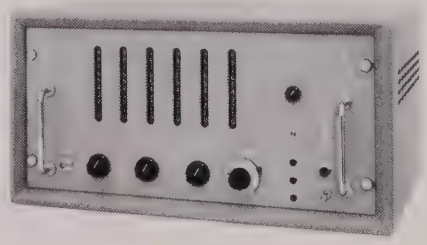


Series 5840 long-life magnetic dual preset counter features FERRISTOR* circuitry; 4-digit, $1115.00; 5-digit, $1200.00; 6-digit, $1295.00.



Series 5420 single preset models range in price from $435.00 for 2-digit capacity to $740.00 for 6-digit capacity. Dual preset Series 5440 range from $650.00 (2-digit) to $895.00 (6-digit).

Nuclear Scalers



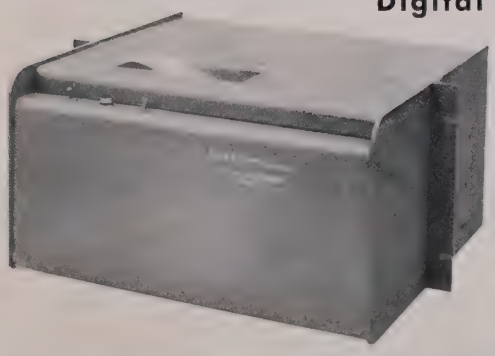
Berkeley's long experience in counting techniques has been carried over to the nuclear field to produce a line of high quality scalers. Model 2025, basically a gated decimal counter, will count, store and record any phenomena occurring in a random fashion. It features automatic reset and start, uses DCUs instead of mechanical registers, and is designed for use with an electronic timer (Model 811) for increased accuracy.

BRIEF SPECIFICATIONS	
	Model 2025
Input:	Pulse Height discriminator with range +5 to +50 volts
Scaling Circuit:	Paired Pulse Resolution: Better than 1 μsec
Integral Amplifiers:	Input Sensitivity: 1 millivolt ± 20%
Controls:	Preset Count Selector — 100 to 4 million in 1-2-4 steps
Price:	$950

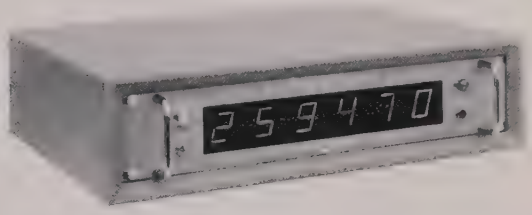
BRIEF SPECIFICATIONS	
	Model 2101
Input Sensitivity:	0.25 volts
Resolving Time:	5 μseconds
Reset:	Reset of register and counting units by single lever
Timer:	Indicates and times automatically to closest second up to 60 min. Accuracy ± 0.2 sec
Price:	$595.00

This scaler weighs only 24 pounds and offers maximum convenience for laboratory work and medical diagnosis. Can be used directly with G-M tubes and scintillation counters. Extremely reliable and simple to operate.

Digital Recorders, Inline Readouts & Transducers



MODEL 1452 DIGITAL PRINTER. Automatically and permanently records information from any Berkeley 5510, 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape from printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted: available in up to 8 digits. One printout every 0.85 seconds. Price (6-digit), $950.00.



MODEL 5916 IN-LINE READOUT. Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5510, 5571 or 7000 Series instrument. Presentation rate up to 15 per second; accepts binary voltages. Price $775.00.

TRANSDUCERS. A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment are available. These include tachometer, pickups, photocells, and light sources. Specifications and technical description on request.

Expanded Scale Voltmeter

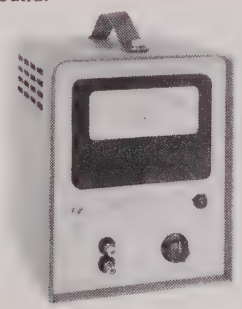
Model 101R Rack Mount.

Model 101-50 expanded scale voltmeter. Featuring: ± 0.25% accuracy, true rms reading, easy to read expanded scale, direct connection for 1 MA recorder.

Brief Specifications: Accuracy—± 0.25% of input voltage; Voltage Indicated—True rms; Voltage Range—100-500 (50-250v); Frequency Range —50-2,000 cps; Scale Range—12v (6v); Price: $360.00 (rack mounted $400.00).

Expanded Scale Frequency Meter

Expanded Scale Frequency Meters are designed for fast accurate monitoring of frequencies near 400 cps. They were originally intended for use in making production inspection measurements of the frequency regulation of motor and engine driven generating units, but many other applications where a record of frequency is desired have been found.



The Model 404 expanded scale frequency meter features Accuracy of ± ½ cycle, 1 MA Recorder Connection Provided; Expanded Scale for easy, error-free reading.

Brief Specifications: Base Frequency—400 cps; Span—± 25 cycles; Accuracy—± ½ cycle; Price—$330.00 (rack mount $380.00).

The Model 100 Transformation Ratio Meter is an RMS reading expanded scale voltmeter designed to read the primary and secondary voltages of synchros faster and easier than by conventional methods. The method of operation is ideally suited for production testing as well as for inspection of synchros and control transformers.

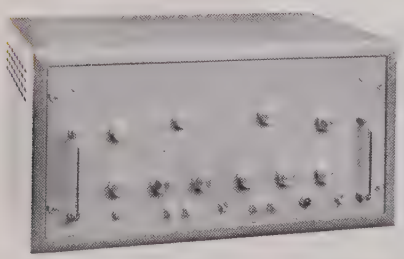
Features: ± 0.2% Accuracy; RMS Reading; Expanded Scale; Read Directly in % Deviation; Simple To Operate For Rapid Production Checks. Price $400.00.

Wide Range Resistance Bridge

The Model 605 wide range resistance bridge provides a means for rapidly and easily checking resistances to a high degree of accuracy. Seven ranges for full scale resistance values are selectable by front panel push button switches. Features: 5 ohms to 100 megohms, push button operation, high accuracy, negligible drift.

Brief Specifications: Resistance Scales—100, 1K, 10K, 100K, 1M, 10M, 100M, Full Scale; Accuracy—± (.15% of resistance measured + .05% Full Scale); Drift—Negligible after 30 minute warm-up; Batteries—1-45 Volt, 2-7½ Volt; Price—$170.00.

Berkeley Double Pulse Generators



Model 4904 Double Pulse Generator

BRIEF SPECIFICATIONS	Model 903	Model 4904
Pulse Width:	0.15 to 1.8 μsec	0.3 to 10 μsec
Rise Time:	0.035 μsec	0.08 μsec
Decay Time:	0.15 μsec	0.26 μsec
Pulse Spacing:	0 to 10 μsec. Single control	0 to 100 μsec. Coarse and fine adjustments
Price:	$498.00	$645.00

Produce paired or single pulses. Pulse amplitude, width, polarity, repetition rate and pulse-to-pulse spacing are independently adjustable. Outputs may be mixed internally or externally. Model 903 can be driven externally by pulses; Model 4904 by pulses or sine wave generators.

APPLICATIONS

Measurement of paired pulse resolution time of counting circuits. Measurement of rise time, decay time and transient response of pulse forming circuits, electronic switches, gates and wide band amplifiers. Calibration of input sensitivity of counting instruments. Frequency calibration of counting rate meters. Measurements of overload characteristics and dynamic range of pulse amplifiers. Delayed coincidence work.

New *EASE** 1100 Series Analog Computers

The 1100 Series introduces a digital output-input translator system (DO/IT) that uses punched tape to set up and check problems, taking much of the human element out of computing and saving hours of operating time. Other new features include automatic static or dynamic problem checking, complete pushbutton monitoring system, and a fully shielded, color-coded patch board. Patch bay capacity 2188 to 3,600 terminals.

A typical setup would include:

- ★ **100 dc amplifiers**
- ★ **16 servos**
- ★ **300 DO/IT controlled attenuators**
- ★ **30 electronic multipliers**
- ★ **250 spare terminals**
- ★ **Required number of trunk lines and terminals for limiters, biases, etc.**

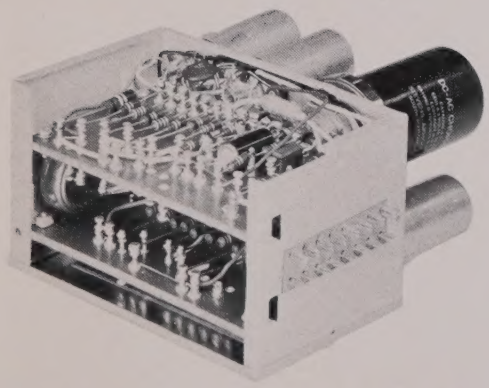
Computing resistors are maintained at an accuracy of better than .005% in a temperature controlled oven. Long-term accuracy of capacitors exceeds .05%. New servo-set potentiometer system permits adjustment of 50K Helipot precision potentiometers to an accuracy of better than 0.01% in less than 3 seconds average time.

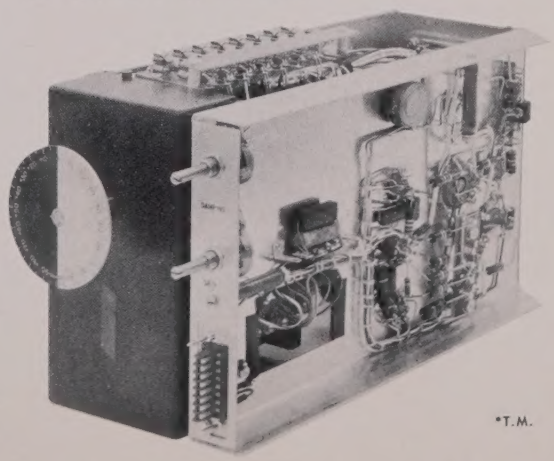
*EASE** Precision Components for Control Systems

Model 1191 General Purpose Servo Multiplier

Up to five variables are multiplied by a sixth in the Model 1191 Servo Multiplier. One, two, or three of the five computing potentiometers can be supplied as sine-cosine resolvers. Amplifiers are removeable for ease of maintenance. The front panel contains servo gain and damping controls, as well as servo error light and a shaft position indicator.

No dither is employed, thus minimizing potentiometer wear. Selection of internal or external feedback reference is made through a relay. Servo Multipliers can also be supplied with such special features as a synchro or one extra potentiometer mounted on the potentiometer shaft, additional taps up to 33 total per potentiometer, and various non-linear resolvers.

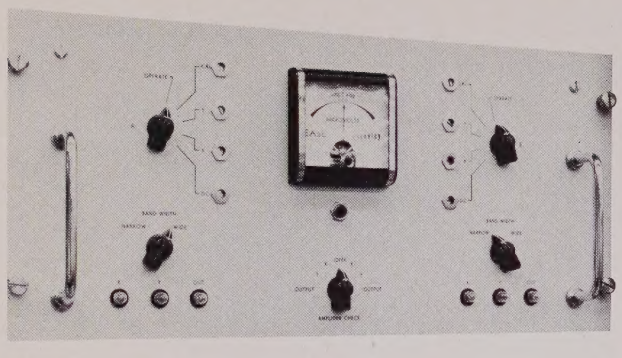




Model 1048B DC Amplifier

This new version of the Model 1048 amplifier, which has become a standard component for industry, features higher out-put current (better than 20 ma) and premium tubes with redesigned circuits for increased tube life.

*T.M.



Model 1157 High Accuracy Electronic Multiplier

Features .02% static accuracy on each of two independent products. Its chopper-stabilized amplifiers are available as inverters and its operation is switched by relay from multiplication to division. Two ranges are available—high accuracy, with a 10KC carrier, and wide band, with a 40KC carrier. This extends the usefulness of the multiplier well beyond the limitations imposed by a single compromise frequency carrier.

Specifications on other 1100 Series components and technical data on the complete computer are available on request. Prices on computer systems may be obtained by writing Sales Manager, Computer, Berkeley Division of Beckman Instruments, Inc., Richmond 3, California.

Customer Services From Beckman/Berkeley

Technical information on all instruments and applications data will gladly be supplied on request. There is no charge or obligation for this service. All literature is prepared by a staff of technical writers who work closely with Berkeley research and applications engineers. Recent literature includes:

Data File 110—FERRISTORS*, Their Use and Application
Data File 111—How to Make Frequency Measurements
Data File 112—How to Make Time Interval Measurements
Data File 10—How to Make WWV Measurements
Data File 123—Analog Computer Solutions for Feedback Control Systems

Beckman/Berkeley Representatives

Berkeley's world-wide staff of factory trained engineering representatives work closely with our sales office and the customer. They help the customer set up newly-purchased equipment, acquaint personnel with its operation and application, and make sure that it stays in operating order. The representative's job is not completed until he has "followed-up" to insure that the customer receives maximum use from his instruments. These men will be glad to give you personal assistance at any time. A list of Berkeley representatives follows.

ALBANY, NEW YORK
Edward A. Ossmann & Associates
16 Caveson Lane
Phone: Union 9-7081

ALBUQUERQUE, NEW MEXICO
V. T. Rupp Co.
8009 Bellamah, N.E.
Phone: Albuquerque 9-4621

ATLANTA 9, GEORGIA
Murphy & Cota
2110 Peachtree St., N.W.
Phone: Trinity 6-300

BINGHAMTON, N. Y.
Edward A. Ossmann & Associates
147 Front St., Vestal, N. Y.
Phone: Endicott 5-0296

BOSTON, MASSACHUSETTS
Broger Instrument Sales Co.
48 Pearl St., Brookline, Mass.
Phone: Beacon 2-4804

CHARLOTTE, NORTH CAROLINA
Murphy & Cota
2036 Norton Rd.
Phone: Edison 2-7356

CHICAGO 39, ILLINOIS
Ridgeway Engineering Assoc.
6100 W. North Ave.
Phone: Tuxedo 9-5715

CLEVELAND 28, OHIO
J. R. Dannemiller Assoc.
3955 Lee Road
Phone: Longacre 1-4567

DALLAS 9, TEXAS
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6815 Oriole Drive
Phone: Fleetwood 2-9918

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Phone: Hemlock 0662

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J. R. Dannemiller Assoc.
1204 North Woodward
Royal Oak, Michigan
Phone: Lincoln 8-4440

HONOLULU 17, HAWAII
Gene Piety
2030 Home Rule St.
Phone: 8-3105

HOUSTON 6, TEXAS
John A. Green Co.
P.O. Box 6445
(Fairview Station)
Phone: Jackson 6-2959

INDIANAPOLIS 2, INDIANA
Ridgeway Engineering Assoc.
1606 N. Illinois St.
Phone: Walnut 5-6464

KANSAS CITY 14, MO.
Leemark Associates
706 E. 73rd St.
Phone: Jackson 3-9299

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Phone: Dunkirk 7-8224

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Murphy & Cota
11375 S.W. 46th St.
Phone: Mohawk 5-1563

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Pinkney & Hine
1925 Nicollet Ave.
Phone: Federal 8-0523

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Gawler-Knoop Co.
835 Glenside Ave., Wyncote, Pa.
Phone: Waverly 7-1820

PORTLAND 14, OREGON
Hawthorne Electronics
700 S. E. Hawthorne Blvd.
Phone: Belmont 4-9375

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830 Linden Ave.
Phone: Hillside 5-0460

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Gawler-Knoop Co.
178 Eagle Rock Ave., Roseland, N. J.
Phone: New Jersey, Caldwell 6-4545

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1500 Big Bend Blvd.
Phone: Mission 7-1470

SALT LAKE CITY 1, UTAH
Gates Company
200 South Main St.,
Phone: Elgin 9-1101

SAN DIEGO 4, CALIFORNIA
V. T. Rupp Company
3948 Utah St.
Phone: Cypress 6-0483

SAN FRANCISCO, CALIFORNIA
Berkeley Division, Beckman Inst.
2200 Wright Ave., Richmond
Phone: Landscape 6-7730

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107 Administration Bldg.
Boeing Field
Phone: Mohawk 3962

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Edward A. Ossmann & Associates
308 Merritt Ave.
Phone: Howard 9-3825

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P.O. Box 911

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8726 Colesville Road,
Silver Spring, Md.
Phone: Juniper 5-7550

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1102 Burke St.
Phone: 4-0750

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R-O-R Associates
6201 Cote St. Lue Road
Phone: Dexter 0845

TORONTO, ONTARIO
R-O-R Associates
1470 Don Mills Rd., Don Mills, Ontario
Phone: Hickory 4-4429

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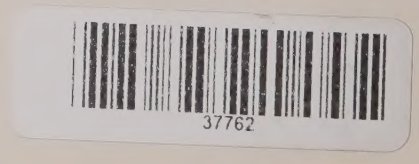
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